# EFFECT OF NEGATIVE PRESSURE ON SELECTED FISHES SALVAGED AT TRACY FISH COLLECTION FACILITY

## Investigators

**Andrew A. Schultz, Ph.D.**
*Fisheries Biologist*
*Tracy Fish Collection Facility*
*Bureau of Reclamation*
*Tracy, CA 94514*
*aschultz@usbr.gov*

**Brent Bridges**
*Fisheries Biologist*
*Tracy Fish Collection Facility*
*Bureau of Reclamation*
*Tracy, CA 94514*
*bbridges@usbr.gov*

## Summary

State and federal water pumping operations of the south Sacramento San Joaquin Delta (Delta) in California require daily collection, handling, holding, transport, and release of salvaged fishes back to the Delta, away from water diversions. This process may inadvertently cause harm to salvaged fishes, including threatened and endangered species. The Bureau of Reclamation (Reclamation) Tracy Fish Collection Facility (TFCF) consists of a system of louvers, bypasses, and collecting/holding tanks to reduce the associated fish loss of its pumping operation. Fish are concentrated by draining each holding tank into a lift bucket, transferred to a fish-haul truck, transported to release sites in the central Delta, and released back to the Delta at fixed release points. The TFCF was originally designed to divert downstream migrating juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from the exported water flow and was not intended to divert and salvage the myriad of fish species that are entrained by current pumping practices. The high catch totals and species diversity, declining abundance of several fish species, elevated quantities of vegetative debris, and legal requirements, have and continue to serve as an impetus for TFCF improvements.

Injury and exposure of fishes to stressors during the salvage process is a concern. Sub-lethal stressors that inhibit disease resistance and predator evasion are also a concern. The lift bucket fish conveyance method has been implicated as one of the greatest sources of stress for fish in the salvage process (Portz 2007). Portz and Sutphin (2009) have proposed to evaluate use of a vacuum pump system at TFCF to remove fish from the recessed, cylindrical holding tanks in times of

increased salvage that is beyond the fish-safe capacity of the lift bucket and transfer these fish to the fish-haul truck. Vacuum systems have been used to transfer fish in a variety of situations (Davis *et al.* 1993; Rode et al. 1991; Baldwin 1973; Grinstead 1969). The potential for a vacuum pump system to release salvaged fishes from the fish-hauling truck back to the Delta in a slower, safer, more adaptable manner, also exists. The current method of release from the fish-haul truck (Churchwell et al. 2005) may produce injuries and/or disorientation from hydraulic jumps, shear forces, debris, etc. within the confined release pipe. Smaller fish are at particular higher risk of injury from such forces. The use of a vacuum-type system to release fishes from the fish-haul truck would allow for water to water transfer of all fish sizes at a slower, more controlled pace than the current method. Current releases occur through pipes at fixed release sites. These release sites are known to accumulate predators attracted by the release of salvaged fishes thereby decreasing survival (Miranda et al. 2010). Certain vacuum-type systems would allow for water-to-water transfer of fishes at areas outside of fixed release sites.

Negative pressures occur in vacuum systems and may injure fish (Turnpenny et al. 2000, and cites therein; Hogan 1941). The potential for fish injury from exposure to negative pressure is related to species characteristics (especially type of swim bladder), magnitude and length of exposure, and ratio of the pressure flux. Hogan (1941) found physostomous fishes were able to make the necessary sudden change or adjustment in the swim bladder when passing through large siphon tubes containing negative pressures, while physoclistous fishes were unable to make the necessary adjustment and suffered hemorrhaging in the circulatory system often leading to mortality. Our study will test the effect of negative pressure on fish species and size classes salvaged at TFCF for which adequate information does not exist. Results will have direct application in evaluating the potential use and limitations of vacuum systems to transfer fishes salvaged by TFCF and other operations.

Data collection has largely been completed for this project. In FY 2014, we seek to finish analyses and complete report.

## Problem Statement

In the ongoing efforts to improve health and survival of fishes salvaged at TFCF, vacuum systems for fish transfer hold promise. However, negative pressures occur in vacuum systems and have been known to injure fish (Turnpenny et al. 2000, and cites therein; Hogan 1941). We will seek to fill information gaps on the effect negative pressure has on health and survival of various fish species and size classes salvaged at the TFCF. This information will assist in evaluating the use of vacuum systems as a fish-safe transfer method.

## Goals and Hypotheses

*Overall Goal:* Provide data that will fill information gaps on the effect negative pressure has on health and survival of various fish species and size classes salvaged at the TFCF.

*Specific Goal:* Quantify survival of fish species and associated size classes salvaged at the TFCF after exposure to varying levels of negative pressure.

*Null Hypothesis:* There is no difference in survival between fishes exposed to negative pressures and fishes remaining at ambient pressure conditions.

Specific null hypotheses will be set for treatments of varying levels of negative pressure and exposure time.

## Materials and Methods

### Source and Care of Fish

The study will occur at the Tracy Aquaculture Facility (TAF) located on the grounds of the TFCF. Juvenile salmonids will be obtained from nearby hatcheries. Adult and juvenile delta smelt will be obtained from the Fish Conservation and Culture Laboratory. Other fishes will be obtained from current stock, salvage operations, or predator removals at TFCF. Fishes will be maintained in circular tanks ranging from 711–2140 L in water volume. All environmental and nutrition parameters will sufficiently meet, or exceed, species requirements. Experimental trials will be conducted at/near oxygen saturation.

### General Procedure

Fishes will be placed into a vacuum chamber partially filled with water and a vacuum pump will be used to draw out air and increase negative pressure to varying levels (up to -12 psi), for varying amounts of time (up to 15 min), and immediately returned to ambient pressure. Density of fishes tested during each trial in the vacuum chamber will vary with size class and species tested but will be on the low-moderate level. Non-normal behavior/appearance (e.g., agitation, loss of equilibrium, or physical damage) will be recorded during and after testing. Fishes will be carefully returned to holding tanks and monitored daily. Control groups will be subjected to all the manipulation experienced by fishes receiving treatment, with the exception of a significant change in pressure. Any mortalities will be recorded and removed. After 4 d all fish will be euthanized and fork length (mm) and overt condition recorded.

### Statistical Analyses

Logistic regression will be used to analyze the effect negative pressure has on mortality levels for various fish species, length classes, and exposure times tested. Trials will be conducted at 4 negative pressures (i.e., 0 [control], 4, 8, and 12 psi) and 3 exposure times (i.e., 1, 5, and 10 min). A probability-mortality curve, with 95% confidence intervals, will be developed.

## Coordination and Collaboration

Study aspects will be coordinated with the Tracy Fish Facilities Improvement Program Manager, research coordinator, and the Tracy Series Editor. Additional comments on design and implementation will be sought from staff at the Tracy Fish Collection Facility and Denver Technical Service Center, and other interested parties. Participation and inclusion of research-related modifications and updates will be provided to the Tracy Technical Advisory Team and/or the Central Valley Fish Facilities Review Team upon request.

## Endangered Species Concerns

This study will not involve the use of wild endangered or threatened species. Hatchery-produced specimens of sensitive species will be sought and used when available.

## Dissemination of Results (Deliverables and Outcomes)

The primary deliverables will be articles published in both the Tracy Volume Series and a peer-reviewed scientific journal. Technical updates will be provided to the Tracy Technical Advisory Team and the Central Valley Fish Facilities Review Team, along with posters and oral presentations given at scientific forums. Additionally, information gained during the study will facilitate future improvements in the fish collection, holding, transport, and release process.

## Literature Cited

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